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Organization, Correlation, and First Results of CONT11

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Abstract

In the second half of September 2011 the continuous VLBI campaign CONT11 was observed. Thirteen globally distributed VLBI stations collected data for fifteen consecutive days without interruption. In addition an ultra-rapid dUT1 determination demonstration was performed on the baseline Onsala–Tsukuba yielding dUT1 estimates with very low latency during the ongoing CONT11 campaign. In this paper we describe the planning and organization of the campaign, give an overview of the correlation effort, and conclude with first analysis results from the campaign.

1. Introduction

The continuous VLBI campaign 2011 (CONT11) was observed with a network of thirteen stations in the period from 15–29 September 2011 (see Figure 1). CONT11 constitutes the sixth

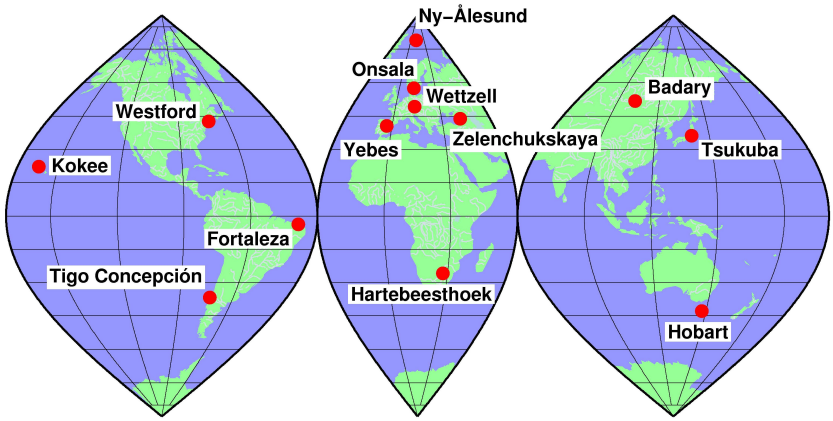

Figure 1. Observational network of thirteen stations of the CONT11 campaign.

continuous VLBI campaign following the successful observations of CONT94, CONT96, CONT02, CONT05, and CONT08. As in previous campaigns, CONT11 acquired state-of-the-art VLBI data

to demonstrate the highest accuracy of which the current VLBI system is capable. Among many possible studies, the data will be used for high-resolution Earth rotation studies, investigations of reference frame stability, and investigations of daily to sub-daily site motions.

2. Campaign Planning and Organization

The planning and organization of CONT11 commenced about a year prior to observing. The Coordinating Center (CC) together with the Observing Program Committee reviewed the necessary resources and analyzed test schedules. Furthermore, dedicated R&D experiments were observed, and extensive station testing was performed under the direction of Brian Corey and Ed Himwich to make sure that the participating stations were in good operating condition before CONT11.

The CC prepared the media usage and shipment schedules as well as the detailed observing schedules and notes. The actual observing was done at a rate of 512 Mbps on the basis of UT days, with each CONT11 day running from 0 UT to 24 UT. UT-day observing is needed to facilitate the most accurate combination and comparison with results from other techniques. In order to avoid observational gaps in the overall network, the station check times were organized in staggered fashion at convenient and well-coordinated times for the stations (Figure 2) and were decoupled from schedule change-overs between CONT11 days.

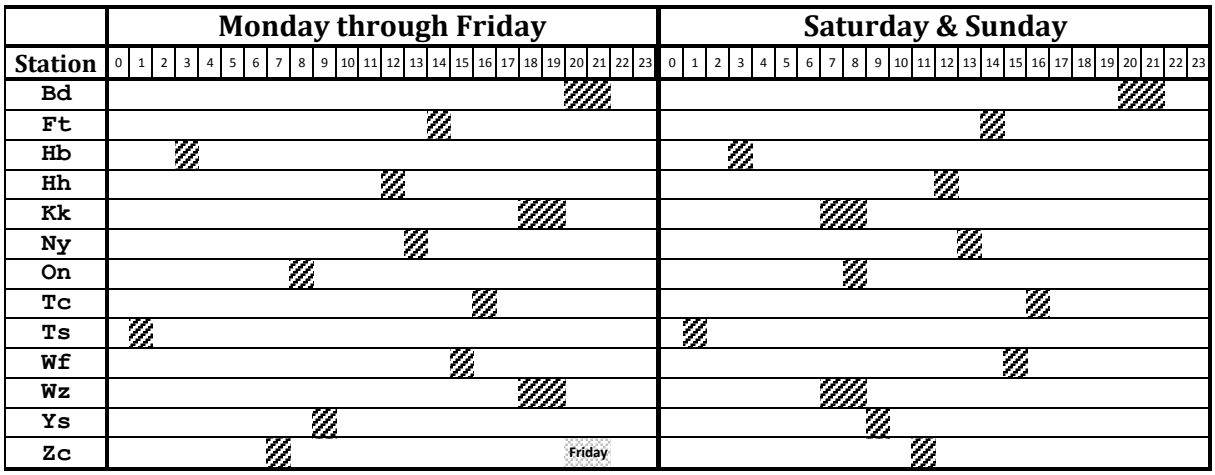

Figure 2. Staggered station check times to avoid observational gaps for days two to fourteen of CONT11.

With the exception of the first and last CONT11 days, all CONT11 sessions had a one-hour slot for each station to perform system and pointing checks. The stations observing Intensive sessions were given two-hour slots. All stations were scheduled in tag-along mode during their check periods so that they could resume observing as soon as possible.

3. Ultra-rapid dUT1 Determination

For the duration of the CONT11 campaign an ultra-rapid dUT1 determination was performed on the baseline Onsala–Tsukuba. Dedicated fiber lines were set up in order to e-transfer the data to the Tsukuba correlator. Near real-time correlation and analysis was performed using a sliding window in the analysis with C5++. dUT1 estimates were obtained with very low latency during

the ongoing CONT11 campaign and displayed on a dedicated Web page. Figure 3 shows the dUT1 estimates and the predicted values for the entire 15 days.

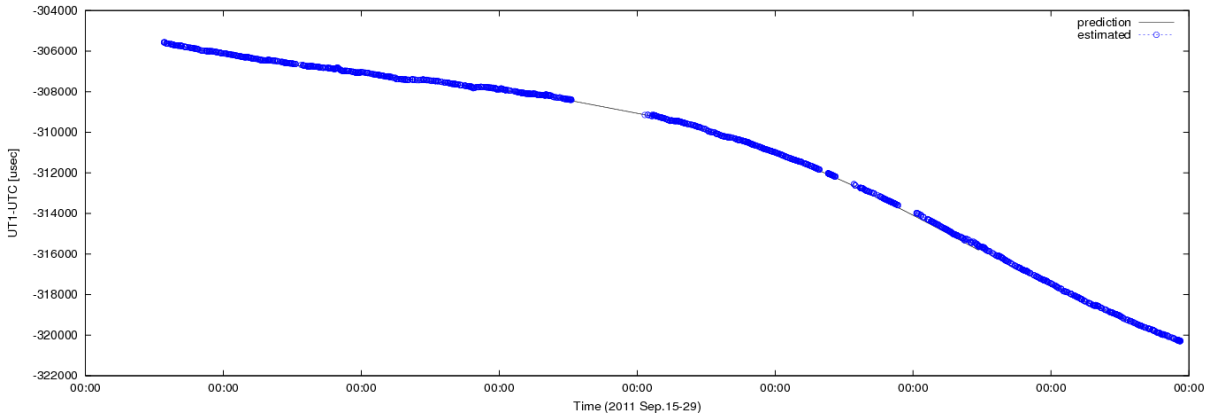

Figure 3. Continuously estimated dUT1 values using C5++ over the full 15 days of the CONT11 campaign.

4. Correlation

For logistical ease and consistency of results, and to gain experience in VLBI2010-type load, correlation was performed at a single correlator: the Washington Correlator correlated the entire CONT11 data set. The correlation parameters, such as station clock values, were kept as smooth and continuous as possible. The clocks for each station were set by examining and fitting the 'fmout-gps' values supplied by the stations (plotted in Figure 4 for six stations). Test correlations were done using the various phase cal tones to try to determine the tones with the least problems over all stations (see, e.g., Figure 4). The final tones (5010 for X-band and 3010 for S-band) were, at the least, no worse than any other set over all stations and 15 days. The final clock values used for correlation are listed in Table 1.

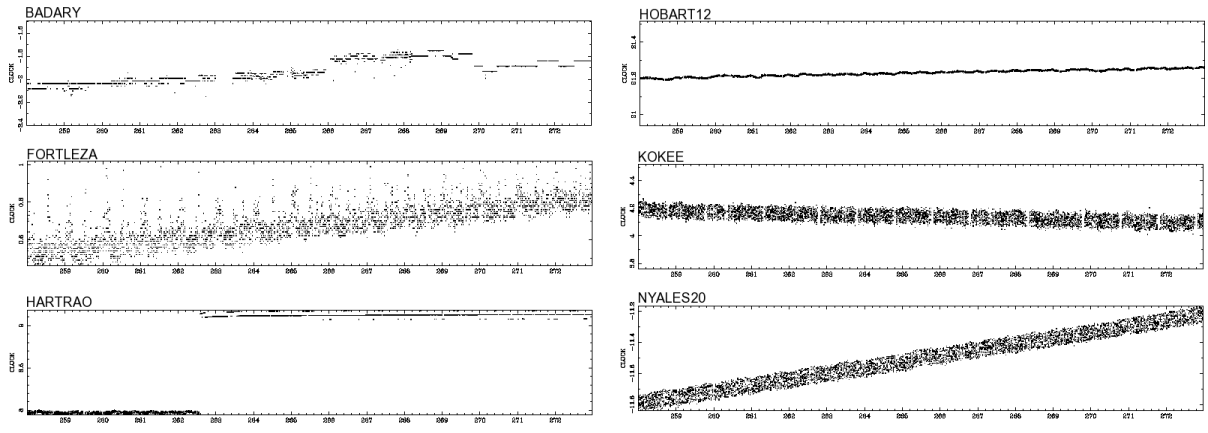

Figure 4. Clock behavior ('fmout–gps') during CONT11 as exemplified at six stations. The clock jump at HartRAO (Hh) is not real but rather is due to a change of the GPS reference receiver.

Table 1. Clock values used for correlating CONT11.

Station	'fmout–gps' [μsec]	Used clock [μsec]	Rate [$\times 10^{-12}$]	Comments
Bd	−2.07	−1.34	0.185	before 266–0000
		−1.20	0.160	266–0000 through 269–2109
		−1.45	0.280	after 269–2109
Ft	0.55	−7.41	0.216	
Hb	21.20	23.87	0.042	
Hh	7.97	8.54	0.006	
Kk	4.19	5.19	−0.072	
Ny	−11.99	−11.59	0.436	
On	−18.31	−26.23	0.498	
Tc	0.72	0.97	−0.0494	
Ts	0.53	1.85	−0.167	
Wf	10.75	10.86	0.008	before 264–1930
	10.75	10.78	0.008	after 264–1930
Wz	−23.34	−31.08	−0.106	
Ys	1.01	0.95	0.361	
Zc	−1.66	−1.29	0.016	

5. First Results

In the correlation process about 10% of the data were removed. The overall quality of the data after correlation is compiled in Table 2. About 97% of the correlated data has quality codes in the range 5–9.

Table 2. Overall correlation results in terms of quality codes.

Qcode	% of total scans	% of corr. scans
5–9	87%	97%
0	2%	2%
B–H	1%	1%

The average formal errors for the EOP are comparable to those of the two previous CONT campaigns. The formal errors are slightly worse in x- and y-pole and universal time, whereas the nutation parameters are better determined (Table 3). The baseline length repeatabilities (scatter) are comparable for the last three CONT campaigns for shorter baselines up to 6,000–7,000 km. For long baselines (8,000-12,000 km) CONT11 has less scatter than the CONT05 or CONT08 campaigns (Figure 5). The scatter in baseline lengths can be reduced by accounting for correlated noise between the observations at the same epoch (scan) on baselines that have a common station (Figure 6). To get a measure of the quality of the polar motion estimates we compared them with GPS estimates. The CONT11 estimates agree much more closely with GPS results (IGS final series) than polar motion from previous continuous VLBI campaigns (Table 4).

Table 3. Average EOP formal errors.

Campaign	xp	yp	dUT1	ψ	ε
	[μas]		[μsec]	[μas]	
CONT05	34	33	1.4	69	27
CONT08	36	34	1.5	59	23
CONT11	37	37	1.6	43	17

Table 4. VLBI–GPS EOP differences.

Campaign	X		Y	
	WRMS	χ^2	WRMS	χ^2
CONT05	65	2.7	40	1.1
CONT08	48	1.4	48	1.6
CONT11	33	0.8	31	0.7

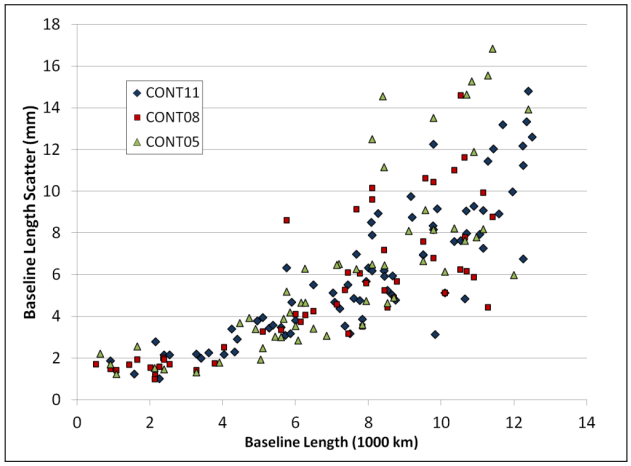

Figure 5. Baseline length scatter of the last three CONT campaigns.

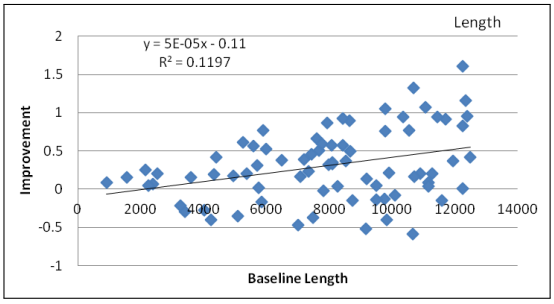

Figure 6. Reduction of baseline length scatter in CONT11 when correlated noise is taken into account.

6. Conclusions

CONT11 is one of the best continuous VLBI campaigns observed yet. It can be considered as a precursor to VLBI2010 continuous observing. Specifically, the staggered individual station check times effectively prevented observational gaps which had caused discontinuities in the high-frequency EOP series in earlier campaigns, and session days were from 0 UT to 24 UT conforming with observing by other geodetic techniques. In terms of analysis results, baseline length repeatabilities and polar motion estimates were better than in previous CONT campaigns. The high quality of this continuous set of data will certainly be valuable for geophysical investigations.